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ABSTRACT

A model for the development of elementary and secondary instructional materials covering the broad range of intellectual skills is presented. The document is a result of a search to identify and evaluate existing instructional materials, classification schemes, models, hierarchies, and taxonomies of cognition. It is presented in four sections. Section I examines models of cognitive processes such as Bloom's Taxonomy of the Cognitive Domain, Dewey's Stages in Problem Solving, Gagne's Conditions of Learning, and Guilford's Structure of the Intellect Model. No single model was found to be ideally suited to the curriculum developer. Section II focuses on 36 sources of curriculum theory organized to literature dealing with general cognitive processes; early childhood, science, and social studies instruction; and specialized skills. The third section presents a taxonomy of cognitive skills. Sixty-three skill-based instructional materials are sorted into the components of the Higher-Order Cognitive Skills Taxonomy. The materials are further divided into three levels: preschool to second grade, third and fourth grade, and fifth grade and beyond. The final section provides bibliographical citations for documents referred to in the report. (Author/KC)

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VARIETIES OF COGNITIVE SKILLS: TAXONOMIES AND MODELS OF THE INTELLECT

by

John W. Thomas

August, 1972

SP 012 104

Abstract

The Higher-Order Cognitive component (HOC) is one of three curriculum development efforts within the Humanizing Learning Program. One mission of the HOC component has been to investigate the domain of cognition in order to discover or develop a taxonomy of cognitive skills which is at once sufficient to describe the varieties of skill instruction previously undertaken and fertile enough to serve as a basis for the development of innovative materials dealing with cognitive skills. To this end, a search was conducted to identify and evaluate existing instructional materials, classification schemes, models, hierarchies and taxonomies of cognition. Analysis and synthesis of this literature resulted in a review of popular classification schemes and available curriculum materials and the development of what seemed to be a comprehensive and viable taxonomy—a working model for the development of instructional materials covering the broad range of intellectual skills.

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Each of the over half dozen types of models discussed, such as:

Bloom's Taxonomy of the Cognitive Domain,
Dewey's Stages in Problem-Solving,
Gagne's Conditions of Learning,
Guilford's Structure of Intellect Model,

has a special use but no single model was found to be ideally suited to meet the needs of the curriculum builder.

CURRICULUM MODELS 12

Over three dozen sources of curriculum theory organized according to literature dealing with:

Cognitive Processes–General,
Early Childhood Instruction,
Science Instruction,
Social Studies Instruction and
Specialized Skills

and the content sorted into the six general areas of the Cognitive Taxonomy presented in this document.

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Sixty-three skill-based instructional materials designed for the elementary school sorted into the components of the Higher-Order Cognitive Skills Taxonomy and further subdivided by level:

Preschool to second grade,
Third and fourth grades,
Fifth grade and beyond.

Many portions of the Higher-Order Cognitive Taxonomy are sparsely represented by available curriculum materials, few of the available materials are skill-oriented and fewer, if any, are sequenced across all grades.

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Provides citations, with a few exceptions, only to those documents actually referred to in the paper. Other bibliographies listing curriculum theory literature and instructional materials appear on pages 18 and 47.

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Varieties of Cognitive Skills

A conceptual framework is a necessary starting point for a curriculum development effort. This paper documents the construction of a framework designed to guide the development of a kindergarten through eighth-grade curriculum focusing on the training of intellectual skills and problem solving. In order to develop a model or taxonomy of cognition that could be used for both descriptive and prescriptive purposes, a search and analysis of educational and psychological literature was undertaken which resulted in a review of the variety of models used to classify cognitive processes, skills, abilities and stages; the development of a tentative taxonomy which was used to organize the cognitive goals of diverse curriculum development projects; and the application and enlargement of this taxonomy through an analysis of the objectives and activities that make up a variety of skill-based instructional programs.

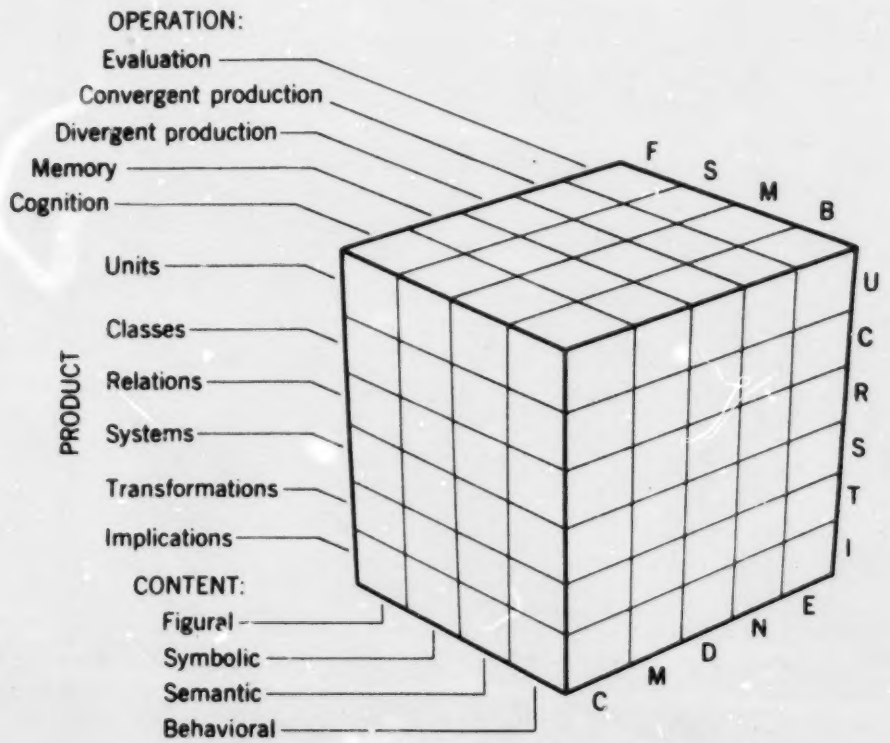
MODELS OF COGNITIVE PROCESSES

Cognitive and experimental psychologists are typically reticent about publishing theories and models of human intellectual behavior. They believe, with good reason, that the scope and variability of intellectual processes cannot be adequately accounted for by any small set of psychological constructs. Historically, attempts at defining such a global theory have met with some disdain and with impossible verification difficulties. The models of the intellect that are to be found in the literature tend to be constructed for specific psychometric, educational or clinical purposes. Consequently, despite apparent similarities or contradictions, these models cannot be considered to be theoretical alternatives. Rather these models or schemes of intelligence, cognitive processes, or problem-solving stages must be treated as heuristic devices with which the psychologist, clinician or educator seeks to organize research findings or further his own research ends.

It is interesting to note that lately there has been a renewed interest on the part of psychologists, and especially educators, in models of intellectual processes. Two trends in psychology have contributed substantially to this phenomenon. Schoolmen and parents have become increasingly critical of the use and misuse of intelligence tests in the schools. For whatever reasons, IQ test scores and resultant differential practices based upon these scores tend to favor the advantaged, English speaking white population. Educators and

school psychologists have begun to look for alternative means of describing academic competence and potential, thus, new models of intelligence are in demand. A related trend began in the early 1960's and centered around research in creativity. Submerged for fifty years, the creative process, or the creative potential, has recently become a legitimate and popular field of inquiry. One of the early results of this type of research was a widely disseminated criticism of the established models of intelligence and academic achievement. It was argued that creative or divergent thinking ability plays an important role in academic achievement, in peer group adjustment, and in the production of innovative ideas in all aspects of life, yet, the creative process has traditionally been ignored as a dimension of intelligence and neglected as an objective of instruction.

A Psychometric Model: Guilford's "structure of the intellect" model has furthered the cause of both of these trends. The model has provided an empirical referent for criticisms of existing IQ measures and has been used by educators, especially, to champion the creative processes against the convergent thinking processes allegedly tapped by intelligence and achievement measures. The model is a psychometric one. Intercorrelations between performance data on a variety of ability tests were manipulated through statistical techniques such that factors were caused to emerge. These factors appeared to be along



three major dimensions. Guilford and his associates then introduced additional ability tests into the analysis in the attempt to define pure measures of independent factors which could be arranged along the intersections of the three dimensions of intelligence.

Operations, according to Guilford, are the intellectual processes – what the individual does with information that comes to his senses. An individual stores and retrieves information, or engages in the process of memory; he comprehends or understands sense data, or cognizes; he generates information in response to determining conditions, or engages in convergent thinking; he generates information under conditions where originality and quality of ideas is stressed, divergent thinking; or he makes judgments about information relative to established criteria, or evaluates. Each of these operations may be performed relative to four different contents or modes of representing information. And the products of operations upon the content may take six different forms dependent upon the way the individual is processing the information. Of the 120 separate abilities described by the model, something in excess of 80 have been defined operationally to date.

Psychologists tend not to be ambivalent about this model. They are either unalterably opposed to it in all of its ramifications, or they believe that it offers valuable implications usually beyond those of Guilford. Without attempting to review the voluminous literature for and against Guilford's research, suffice it to say that the adherents of the model stress its utility for defining educational objectives and its critics stress its tenuous predictive validity. Attempts have been made to devise instructional objectives directly from the cells of the model (Karnes, 1970; Meeker, 1969) while other psychologists have altered the model to fit their own instructional interests, e.g., Williams (1970).

Without a doubt, the most pervading aspect of the model is that it includes a dichotomy of sorts between convergent and divergent production; between creativity and the more constrained, typical academic thinking activities. A number of investigations into creativity followed Guilford's (1959) presentation of the model (Getzels and Jackson, 1962; Torrance, 1965; Wallach and Kogan, 1965; Yamamoto, 1964). Substantial evidence was compiled in support of the claim that divergent thinking ability was related to academic success. In addition, support was amassed for the separate dimensionality of creativity and intelligence.

The creativity (divergent thinking) vs. intelligence (convergent thinking) controversy may serve to illustrate the utility of Guilford's model for education. Criticisms of its validity and its predictive significance not withstanding, the model should serve to promote more varied and multidimensional conceptions of educational objectives.

A Task Analysis Model: Classification of cognitive processes can have another kind of empirical base, task analysis. Psychologists using this technique are interested in defining the total number of discrete performances necessary to carry out a particular task or set of tasks. Gagne's learning model, as well as the majority of problem-solving models, stems from

task analysis and research into the qualitatively different sorts of performances that serve as prerequisites for complex tasks.

Gagne's model is a classification of the variety of learning paradigms. For Gagne, learning a simple stimulus-response chain is not only easier than learning to solve a problem, but also the conditions under which the learning occurs, the nature of the response, and the internal conditions of the learner are necessarily different in each case. The following summary is from Gagne (1970, p.334):

SUMMARY OF ESSENTIAL CONDITIONS APPROPRIATE FOR EACH TYPE OF LEARNING

Learning Type	Prerequisite Capability	External Conditions of Learning
Ss→R Connection	Apprehension of stimulus	Presentation of stimulus so that desired response will be contiguous in time and supply contingent reinforcement.
Motor Chain	Individual connections	A sequence of external cues, stimulating a sequence of specific responses contiguous in time; repetition for selection of correct response-produced stimuli.
Verbal Chain	Individual connections including "coding" links	A sequence of external verbal cues, stimulating a sequence of verbal responses contiguous in time; repetition may be necessary to reduce interference.
Discrimination	Apprehension of stimulus	Practice providing contrast of correct and incorrect stimuli; or, practice providing progressive reduction in stimulus differences.
Concrete Concept	Discriminations	Responding to a variety of stimuli differing in appearance, belonging to a single class.
Rule, including Defined Concepts	Concepts	External cues, usually verbal, stimulate the formation of component concepts contiguously in a proper sequence; application is made in specific examples.
Higher-Order Rule —Problem Solving	Rules	Self-arousal and selection of previously learned rules to achieve a novel combination.

In contrast to Guilford's model, problem-solving models, and information-processing models, Gagne's cumulative learning model deals with thought processes through the specification of the characteristic performances by which the processes are expressed and

the particular external and internal conditions prerequisite for the emergence of these processes. The conditions of learning are further elaborated through a specification of the events and procedures of instruction (Gagne, 1970). Gagne's model is not, however, a model of thinking. It's value lies in its utility for deriving instructional objectives, designing curricula to meet the objectives and designing the process of instruction and evaluation. If one's interest is in developing a problem-solving curriculum, the model would not describe the variety of problem types or problem-solving processes and strategies. However, the model could contribute to the design of each portion of the curriculum insofar as it specifies the kind of prerequisite learnings necessary and the instructional conditions which would maximize transfer to the criterion tasks.

A Taxonomy Of Cognitive Objectives: Another model based upon task analysis is Bloom's "taxonomy of educational objectives" of the cognitive domain (1956). Rather than being a classification of the variety of learning paradigms, it is a taxonomy of the variety of educational objectives. Consequently, it spans learning tasks and the more abstract goals of instruction that have to do with thinking about the content of learning tasks. Bloom's cognitive taxonomy is as follows:

Bloom's Taxonomy of the Cognitive Domain

Evaluation:	Judgment by internal criteria Judgment by external evidence
Synthesis:	Derivation of abstract relations Production of plan-pattern Production of uniqueness
Analysis:	Organizational principles Relationships Elements
Application:	Particular and concrete Situations
Comprehension:	Extrapolation Interpretation Translation
Knowledge:	Classifications—categories Sequences—series Specific facts Terminology Recall of information

Bloom's model is a descriptive one. Whatever hierarchical qualities are attributed to it by Bloom and others are logical and not psychological. In contrast to Guilford's model, Bloom's taxonomy is sufficiently general to create difficulties in interpretation, yet it has proven to be quite useful as a classroom observation or evaluation scale and as a guide in using inquiry or discovery methods. The taxonomy does share one thing in common with Guilford's model. It is best used by a curriculum planner as a reference rather than as a framework for the derivation of objectives. Deriving (as opposed to specifying) objectives from a descriptive model of educational practices or from a model of testable human abilities is, in reality, tantamount to perpetuating an existing state of affairs.

A Developmental Model: Cognitive-developmental research can hardly be ignored in any discussion of models of thought processes. Piaget's analysis of the development of hypothetico-deductive or formal reasoning has introduced many constructs into the psychologists repertoire. More importantly, Piaget has been influential in the growth of a new breed of psychologists interested in human thought processes, intelligence and problem solving. The unique aspect of this approach to cognition is the belief that complex intellectual behavior is best understood and defined via an analysis of the developmental sequence through which it emerges. For Piaget, the child progresses through an invariant sequence of qualitative changes in his cognitive structure. These changes are observable through an analysis of the logical explanations the child volunteers relative to a variety of external events. The characteristics listed on the chart below, which elsewhere are considered to be cognitive skills, problem-solving processes, human abilities, etc., are, for Piaget, attributes to cognitive adaptation – of the successful attainment of stages of intellectual development. The following chart is taken from an article by Williams (1969):

Piaget's Stage Theory of Intellectual Development

Formal Operations Stage
- Abstract-conceptual thinking
- Reasoning generalized
- Evaluation
- Hypothesizing
- Imagining
- Synthesizing

Concrete Operations Stage
- Analyzing
- Conscious of dynamic variables
- Measures
- Classifies things in groups or series

Pre-Operational Stage
- Symbols and representations
- Acts on perceptive impulses
- Self-centered
- Static-irreversible thinking

Sensory-Motor Stage
- Mute – no use of verbal symbols
- Learns to perceive – discriminate and identify objects

Similarities and differences between Piaget's and psychometricians' conceptions of intelligence have been competently discussed by Elkind (1969). Likewise, a comparison between Piaget's views on the development of intellectual skills relative to the views of learning psychologists is treated by Gagne (1968), Kohlberg (1968), and Rohwer (1970). Despite the fact that Piaget's writings are not notable for their pedagogical prescriptions, it is fair to say that any attempt to define teachable cognitive skills for an elementary school curriculum must consider the qualitative differences in intellectual competence exhibited by children of different ages. And insofar as these deficiencies represent stages of development and are not amenable to instruction, the curriculum planner must be quite cautious in planning instruction which matches the cognitive structure and learning readiness of the child.

Problem-Solving Models: One of the oldest conceptions of the nature of thought is concerned with the logical stages or distinct steps involved in a complex thinking act, usually problem-solving. Dewey's five steps have been both expanded and reduced yet their appropriateness as a model has not lost favor since 1910. The original steps and their revised equivalents are taken from Getzels (1964) and Dewey (1933) respectively:

1. a felt difficulty (recognize problem)
2. location and definition (analyze problem)
3. suggestion of a possible solution (generate solution)
4. development by reasoning of the bearings of the suggestion (test consequences)
5. further observation and experiment leading to its acceptance or rejection (judge selected solutions)

Samples of other stage conceptions of the thinking process are listed on the following page.

STAGES IN THE PROBLEM SOLVING PROCESS

BINET (1909)

Direction
Comprehension
Invention
Criticism

BUHL

Recognition
Definition
Preparation
Analysis
Synthesis
Evaluation
Presentation

CRUTCHFIELD

Problem formulation
Information processing
Idea generation
Idea evaluation

DEWEY

Difficulty felt
Difficulty located and defined
Possible solutions suggested
Consequences considered
Solution accepted

EMERY

List deviations
Set priorities
Define deviation
Identify differences
List changes
Develop possible cause
Test possible cause
Operating test on cause
Design corrective alternative
Evaluate

GORDON

Problem as given
Make strange familiar
Problem as understood
Operational mechanisms
Make familiar strange
Psychological states
States integrated w/problem
Viewpoint
Solution or research target

GREGORY

Decide on objective
Analyze problem
Gather data
Organize data
Induction
Planning
Pre-checking
Activate plans
Evaluate

KAUFMAN

Identify problem from needs
Determine solutions, requirements, and alternatives
Select solution strategy from alternatives
Implement solution strategy
Determine performance strategy
Revise as necessary

KEPNER/TREGOE

Recognize problems
Separate and set priorities
Specify deviation
Determine distinctions
Find relevant change
Develop possible cause
Test for cause
Establish objectives
Classify objectives
Develop alternatives
Evaluate alternatives
Choose best one
Assess adverse consequences
Control effects in final decision

LAIRD/GROTE

Recognize and identify problem
Gather information to solve problem
Determine cause of problem
Generate possible solutions
Select solution to do best job
Put solution into practice

MILES

Orientation
Information
Speculation
Analysis
Program planning
Program execution
Status summary and conclusion

OSBORN

Orientation
Analysis
Preparation
Hypothesis
Incubation
Synthesis
Verification

PARNES

Fact finding
Problem finding
Idea finding
Solution finding

POLYA

Understanding the problem
Devising a plan to solve the problem
Carrying out the plan
Looking back

ROSSMAN

Need observed
Problem formulated
Available information surveyed
Solutions formulated
Solutions examined
New ideas formulated

SHULMAN (1968)

Problem sensitivity
Problem formulation
Search behavior
Resolution

TORRANCE (1962)

Observation
Definition
Preparation
Analysis
Ideation
Incubation
Synthesis
Evaluation
Development

UPTON/SAMSON

Tentative statement of problem
Multiple definition of key terms
Working definition or restatement of problem
Working classification
Classification of collected specimens
Analysis of planned structure
Analysis of planned operation
Analysis of past/existing operation
Induction
Deduction
Planned execution
Planned evaluation
Execution
Evaluation

Varieties of Problem-Solving Paradigms: These models of problem-solving processes or stages seem at once to be highly similar in nature and at the same time to be arbitrary relative to the choice of words and the number of steps included. Undoubtedly, this ambiguity arises from the tremendous variance that exists in the types and complexity of problematic situations. Keislar (1969) identifies 13 dimensions upon which problem-solving events may vary:

1. variables dealt with
2. the extent to which the problem must be defined
3. the extent to which the environment supplies cues
4. the extent to which incentives are external or internal
5. the extent to which the problem has rules or a standard method
6. the extent to which responses are required for the solution
7. the extent to which the problem demands convergence vs. divergence
8. the extent to which the outcome is the learning of a principle or a procedure
9. the extent to which the learning of the solution is going to generalize
10. the educational importance of the problem or the extent to which this learning facilitates learning to solve more advanced problems
11. the extent to which the learner has mastered prerequisites
12. the extent to which the learner has mastered prerequisite procedures or strategies for this type of problem
13. the extent to which the learner has acquired broad patterns of behavior conducive to this type of problem

Getzels (1964) lists eight different types of problems which vary according to whether the problem is presented or remains to be discovered, whether a standard method exists for dealing with it, whether this method is known by the problem solver and whether the method is known by others. Similarly, Bruner (1970) makes the distinction between problem solving and problem finding, pointing out that, in life, problems are seldom presented fully defined, hence the processes and skills involved in finding and defining problems may be more important for educational purposes than the processes of problem solving.

It is possible, of course, to pursue each one of Keislar's 13 variables and arbitrarily present a dichotomy characterizing two distinct types of problems. One of the most important variables for instruction in problem solving has to do with Keislar's fifth point, whether or not a problem has a well-defined method for its solution. Black (1946) makes the distinction between "rule-constituted" acts and "rule-governed" acts, where the former include instrumental acts towards some solution or goal which are constrained, determined or at least defined by rules that specify contingencies and consequences. The latter class of actions is one whereby rules afford a certain amount of guidance for the achievement of a solution, but a wide latitude exists in methods and outcomes that satisfy the problem. Solving a quadratic equation problem is a rule-constituted act whereas solving architectural

design problems is a rule-governed act. Olton and Crutchfield (1969) expand this distinction to include the difference between having students rediscover the known (e.g., arithmetic problems, workbook exercises, science experiments) and having them work "in an organized, planned manner on problems that seem to resist solution, formulating and evaluating new possibilities, and developing a sensitivity to odd or unusual circumstances that may lead to a discovery or fresh insight."

The scope of this distinction can be widened even further to include open-ended problems which do not demand organized, planned study, but rather imaginative expression or insight. The problems used by Torrance (1967), for example, in his tests and his curriculum materials on creativity are almost rule free with respect to the limitations placed upon the student's responses. They are problems designed not to be instructive so much as to be facilitating of original or divergent expression.

Without belaboring the point any further, it might be instructive to present additional problem-solving classifications which are attempts at defining qualitatively different classes of problematic situations or processes that refer to these classes:

TYPES OF PROBLEM-SOLVING PARADIGMS

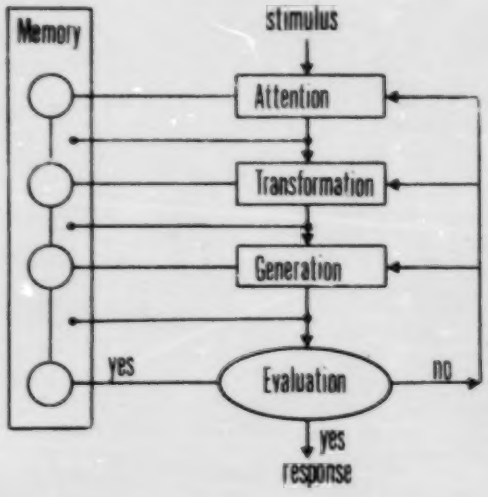
Parnes (1967)	Berman (1967)	Bruner (1962)
producing and developing	dealing with the known	acquisition
evaluating and verifying	reaching beyond the known	transformation
defining problems	judging, rating and evaluating	evaluation

Selye (1964)	Osborn (1963)
true (a search for)	fact finding
surprizing	idea finding
generalizable	solution finding

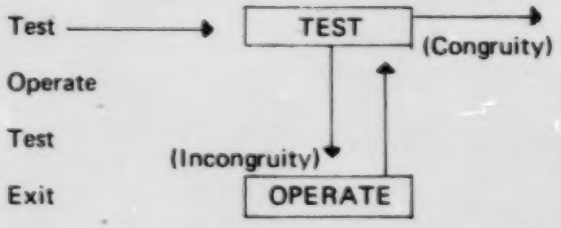
Information-Processing Models: The schemes outlined above are of the sort found in educational literature. Research literature on problem solving contains many additional constructs, dimensions and classification schemes relative to thought processes. (See, for example, Davis, 1966; Kleinmuntz, 1966.) One other approach to problem-solving processes – information-processing modes – is worthy of mention here. In an attempt to simulate the operation of the human mind by studying and adapting the computer, psychologists have promised both a fuller understanding of the human brain and a more efficient means of

teaching problem solving. Selected examples of information-processing models are the following:

"Schematic representation of a general operational model of information processing with four functional stages of cognitive processes." (Fletcher, 1969)



The TOTE Unit (Miller, Galanter and Pribram, 1960)



More elaborate information-processing schemes have been prepared by Newell and Simon (1961), Gregory (1967), Guilford (1967) and Reitman (1970). Keislar (1968) suggests that curriculum development is underway to translate the information-processing framework into problem-solving strategies for school children.

CURRICULUM MODELS

Literature dealing with curriculum theory, including teacher's guides to instructional material, provides another source of taxonomies of cognitive processes. Thirty-nine taxonomies found through a search of curriculum literature, despite some degree of redundancy, were sufficiently varied in both purpose and abstractness to necessitate the development of a superordinate classification scheme.

The classification scheme below, entitled the Higher-Order Cognitive Taxonomy, was used to sort the cognitive processes emphasized by curriculum specialists.

The Higher-Order Cognitive Taxonomy:

I Learning-to-Learn Processes
II Communication Processes
III Classifying and Comparing Processes
IV Synthesizing and Producing Processes
V Judging and Evaluating Processes
VI Value Analysis and Decision-making Processes

Taxonomies of the Cognitive Domain

I. Cognitive Processes -- General

CLASSES OF HIGHER ORDER COGNITIVE PROCESSES	Berman, L.M., 1967 (Cognitive Processes)	Bloom, B.S., et al., 1956 (Cognitive Objectives)	Burns, R.W. and G.D. Brooks, 1970 (Cognitive Processes)	Cole, H.P., 1969 (Intellectual Processes)	Gerhard, M., 1971 (Cognitive Strategies)	Guilford, J.P., 1967 (Cognitive Abilities)	Hills, J.L., 1969 (Cognitive Processes)	Raths, L.E. et al., 1967 (Thinking Operations)	Williams, F.E. National Schools Project, 1970 (Primary Mental Abilities)
I LEARNING TO LEARN PROCESSES	Organizing	Comprehension Knowledge		Attending and Orienting Listening Direction Following Observation Skills		Memory Cognition	Attending		Cognitive Ability Awareness Comprehension Memory Storage Retention
II COMMUNICATION PROCESSES	Summarizing	Application	Abstracting	Translation and Transformation Figural Decoding			Observing	Observing Summarizing	
III CLASSIFYING AND COMPARING PROCESSES	Classifying Defining Comparing Analyzing	Analysis	Classifying Sequencing Equating Analyzing	Classification Perceptual and Cognitive Discrimination Attribute Identification Serial Ordering Iteration Measurement	Classifying/Categorizing Concept Formation Comparing Analysis Convergent Thinking	Convergent Thinking	Classifying Comparing/Contrasting	Classifying Comparing Interpreting	Convergent Thinking Redefinition Transformations Best Solution Improvisations
IV SYNTHESIZING AND PRODUCING PROCESSES	Fluency Flexibility Originality Ability to Elaborate Predicting Consequences Seeing Causes Synthesizing Generalizing Sensitivity to Problems	Synthesis	Synthesizing Generalizing Simulating Theorizing Translating	Flexibility and Divergence Diver. Interpretation Diver. Production Fluency Elaboration Decentration Inquiry Problem Solving	Associating Inductive Reasoning Reasoning Synthesis Creative Thinking Divergent Thinking	Divergent Thinking	Predicting	Imagining Hypothesizing Applying Facts and Principles in New Situations Designing Projects or Investigations	Divergent Thinking Fluency Flexibility Originality Elaboration
V JUDGING AND EVALUATING PROCESSES	Criticizing Interpreting Data Asking Useful Questions	Evaluation	Evaluating Inferring		Deductive Reasoning Critical Thinking	Evaluation	Making Inferences, Generalizations Operational Defining Testing a Hypothesis Formulation of a Model	Coding Criticizing Looking for Assumptions Collecting and Organizing Data	Evaluative Ability
VI VALUE ANALYSIS AND DECISION MAKING PROCESSES							Valuing Decision Making Policy Making Conceptualization of Values	Decision Making	

Taxonomies of the Cognitive Domain

II. Early Childhood Instruction

CLASSES OF HIGHER ORDER COGNITIVE PROCESSES	Bank Street College of Education, Early Childhood Discovery Program, 1969 K (Skills)	Dunn, L.M., J.O. Smith, and K.B. Horton: Peabody Language Development Kits, 1965 P.3 (Skills)	Kamii, C.K., 1971 P.1 (Cognitive Objectives)	Let's Look at Children, 1965 1 (Cognitive Skills)	Marshall, J.S., I. Podendorf, and C. Schwartz: Sense and Tell, 1968 P.K. (Processes)	OISE Conceptual Skills Program, 1967 K (Skills)	Parker, R.K. and D.C. Whitney, 1971 P.3 (Basic Learning Skill Areas)	Resnick, L.B. Primary Education Program, 1968 K-3 (Skills)	Scott, R., et al. Learning Readiness System, 1968 P.1 (Cognitive Abilities)
I LEARNING TO LEARN PROCESSES	Auditory Discrimination Perceptual Skills Discrimination	Following Directions Listening Memory Patterning		Auditory Discrimination and Attention Listening Comprehension Learning Shapes and Forms Spatial Perspective			Listening Improving Memory Following Directions Understanding Rules Expanding Vocabulary	Orienting and Attending Sensory Memory Spatial and Locational	Patterning Listening
II COMMUNICATION PROCESSES	Language Skills	Describing	Physical Knowledge	Learning to Communicate Understanding Cause and Effect Language for Thinking	Communicating Observing	Communication Skills Describing Giving Instructions Getting Instructions	Observing Speaking	Language (functional use) Language (linguistic accuracy)	Language Skills
III CLASSIFYING AND COMPARING PROCESSES	Conceptual Skills Classifying Relating Sequencing Interpreting	Convergent Thinking Classification	Logical Knowledge Classification Seriation Numerical Construction Structuring of Space Structuring of Time	Notion of Time Logical Classification Concepts of Relationship One-to-One Correspondence Number Relations	Classifying	Relationships Identification	Recognizing Characteristics Classifying Telling Time Measuring Counting Alphabet Understanding Numbers	Classification Skills In Using Examples Measurement Quantitative Geometric	Classifying Seriating Relating
IV SYNTHESIZING AND PRODUCING PROCESSES		Divergent Thinking Associative Thinking Brainstorming Imagining		Reasoning by Association Developing Imagination			Solving Problems Drawing and Design Making and Building	Plan Following and Pattern Recognition	
V JUDGING AND EVALUATING PROCESSES		Critical Thinking	Representation at The Simple Level Representation at The Language Level	Reasoning by Inference	Inferring		Predicting and Testing	Problem Solving	
VI VALUE ANALYSIS AND DECISION MAKING PROCESSES	Perceptual Skills Awareness		Social Knowledge	Awareness			Relations With Others		

Taxonomies of the Cognitive Domain

CLASSES OF HIGHER ORDER COGNITIVE PROCESSES	AAAS Science – A Process Approach, 1968 K-6 (Processes)	Karplus, R. Science Curriculum Improvement Study, 1970 (Processes)	Klopfer, L.E. 1971 K-12 (Processes)	Man in a World of Change, 1971 1-6 (Processes)	Merrick, P.D. Inquiry, Discovery and Invention, 1969 5-10 (Science Processes)	Presno, V. and C. Presno. Man in Action Series, 1967 K-6 (Cognitive Processes)	Syrocki, J.B. and T.W. Munch. Science for a Changing World. 1967 K-6 (Processes)	Warntz, J. MINNEMAST, 1970 K-3 (Processes)	
I LEARNING TO LEARN PROCESSES									
II COMMUNICATION PROCESSES	Communicating Observing	Observation Communication	Observing	Observing Communicating	Observation Mapping the Location of Objects	Observation Description	Observing Communicating	Observation Description	
III CLASSIFYING AND COMPARING PROCESSES	Using Space/Time Relationships Measuring Classifying Using Numbers	Classification Measurement Relating Information	Measuring	Classifying Measuring	Comparing Contrasting Classification	Classification Seriation Correspondence	Classifying Measuring Using Number/Time/Space Relationships	Classification	
IV SYNTHESIZING AND PRODUCING PROCESSES	Formulating Hypotheses Predicting	Prediction Suggesting Hypotheses	Problem Recognition Problem Solving	Forming Models Predicting Hypothesizing			Predicting	Formulating Relationships Formulating Hypotheses	
V JUDGING AND EVALUATING PROCESSES	Inferring Controlling Variables Interpreting Data Defining Operationally Experimenting	Collecting Evidence Inference Making Assumptions Defining Interpreting Data	Interpreting Data Formulating Generalizations Building a Model Testing a Model Revising a Model Application of Scientific Knowledge	Inferring Interpreting Data		Disjunctive	Inferring Experimenting	Testing Hypotheses Logical Reasoning Inductive Reasoning Inference Deductive Reasoning Speculation	
VI VALUE ANALYSIS AND DECISION MAKING PROCESSES								Detection of Analogies	

Taxonomies of the Cognitive Domain

CLASSES OF HIGHER ORDER COGNITIVE PROCESSES	Fideler, R.E., et al. (eds.) Man and Communities, 1970 K-6 (Thought Processes)	Johns, E. and D. McC. Fraser, 1963 K-12 (Skills)	Lippitt, R., R. Fox, and L. Schaible, Social Science Laboratory Units, 1969 4-6 (Processes)	Man: A Course of Study, 1968 5 (Skills)	MATCH Project, 1968 K-4 (Skills)	Orlandi, L.R., 1971 K-12 (Skills)			
I LEARNING TO LEARN PROCESSES	Remembering	Locating Information Organizing Information Acquiring/Reading Acquiring/Listening Observing		Spatial Structuring Attending		Research Location of Information Interpretation of Graphic and Symbolic Data			
II COMMUNICATION PROCESSES		Communicating Orally In Writing	Describing Observing Group Work Skills Verbal and Non-Verbal Communication	Communicating Observation	Mapping Skills				
III CLASSIFYING AND COMPARING PROCESSES	Analysis Translation Interpretation Application	Interpreting Maps and Globes Understanding Time and Chronology Interpreting Charts, Graphs, Tables		Inquiry Classifying	Classification				
IV SYNTHESIZING AND PRODUCING PROCESSES	Synthesis		Predicting Problem Solving and Inquiry Data Collection Hypothesis Formation	Hypothesizing Predicting	Role Playing Problem Solving				
V JUDGING AND EVALUATING PROCESSES	Evaluation	Evaluating Information Applying Problem Solving and Critical Thinking Skills	Inferring Generalizing	Interpreting Data Inferring Defining Operationally		Critical Thinking Indentification of Central Issues and Underlying Assumptions Evaluation of Evidence and Drawing of Warranted Conclusions Formulation of Reasonable Hypotheses			
VI VALUE ANALYSIS AND DECISION MAKING PROCESSES		Working With Others	Decision Making	Representing Experience		Democratic Group Participation Formal Procedures Informal Procedures			

Taxonomies of the Cognitive Domain

V. Specialized Skills

CLASSES OF HIGHER ORDER COGNITIVE PROCESSES	Fournier, R. Thinking and Writing Series, 1969 3-6 (Composition Skills)	Cooney, T.J. and K.B. Henderson, 1971 (Cognitive Activities)	Crosmar, M.C., et al., 1985 (Study Skills)	Heathcote School, 1983 K-6 (Thinking Opportunities)	Milwaukee Speech and Language Program, 1968 K-3 (Language Skills)	Wassermann, S., J. Wassermann, and L. Raths. Thinking Skills Development Program 5-9 (Critical Thinking Processes)			
I LEARNING TO LEARN PROCESSES			Listening Locating Information Organizing Information Retaining Information Reading	Listening	Memory Decoding				
II COMMUNICATION PROCESSES	Explanation Description Composition		Communication Skills	Observing Stating/Defending Position Summarizing	Encoding	Summarizing Observing			
III CLASSIFYING AND COMPARING PROCESSES	Interpretation Classification Order	Analyzing Analysis Specifying Characterizing Classifying Set Membership Set Inclusion		Comparing Classifying		Comparing Interpreting Classifying			
IV SYNTHESIZING AND PRODUCING PROCESSES		Inductive Generalizing Abstracting	Integrating Information	Imagining Reviewing Alternatives Problem Solving	Associative Problem Solving	Hypothesizing Imagining Problem Solving			
V JUDGING AND EVALUATING PROCESSES	Argumentation	Deductive Explaining Implicating	Selecting and Evaluating	Interpreting Data Recognizing Assumptions Criticizing Testing A Hypothesis		Coding Criticizing Looking for Assumptions Collecting and Organizing Data			
VI VALUE ANALYSIS AND DECISION MAKING PROCESSES				Analyzing Others Thinking Habits					

TAXONOMIES OF THE COGNITIVE DOMAIN

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Berman, L. M. From Thinking to Behaving: Assignments Reconsidered. Ne.. York: Teachers College Press, 1967.

Bloom, B. S., et al. (eds.). Taxonomy of Educational Objectives: Handbook I - Cognitive Domain, New York: David McKay Company, 1956.

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Guilford, J. P. The Nature of Human Intelligence. New York: McGraw-Hill, 1967.

Hills, J. L. "A Synthesis of Cognitive and Affective Processes in Social Studies Instruction." Paper presented at the annual American Educational Research Association meeting, Los Angeles, February, 1969.

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II. Early Childhood Instruction

Bank Street College of Education. Early Childhood Discovery Materials. New York: Macmillan Company, 1969.

Dunn, L. M., J. O. Smith, and K. B. Horton. Peabody Language Development Kits. Circle Pines, Minn.: American Guidance Service, 1965.

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Resnick, L.B. Design of an Early Learning Curriculum. Pittsburgh: Learning Research and Development Center, University of Pittsburgh, 1967.

Scott, R., et al. Learning Readiness System--Classification and Seriation Kit. Evanston, Ill.: Harper and Row, 1968.

III. Science Instruction

American Association for the Advancement of Science. Science--A Process Approach. New York: Xerox Corporation, 1968.

Karplus, R. "Theoretical Background of the Science Curriculum Improvement Study." Berkeley: Science Curriculum Improvement Study, University of California, 1965.

Klopfer, L. E. "Evaluation of Learning in Science," Handbook on Formative and Summative Evaluation of Student Learning, B. S. Bloom, et al. (eds.). New York: McGraw-Hill, 1971.

Man in a World of Change. Westchester, Ill.: Benefic Press, 1971.

Merrick, P. D. Inquiry, Discovery and Invention. San Leandro, Calif.: Educational Science Consultants, 1969.

Presno, V. and C. Presno. Man in Action Series: People and Their Actions in Social Roles. Englewood Cliffs, N. J.: Prentice-Hall, 1967.

Syrocki, J. B. and T. W. Munch. Science for a Changing World. Westchester, Ill.: Benefic Press, 1967.

Werntz, J. Minnesota Mathematics and Science Teaching Project (MINNEMAST). Minneapolis: University of Minnesota, 1970.

IV. Social Studies Instruction

Fideler, R. E., et al. (eds.). Man and Communities. Grand Rapids, Mich.: Fideler Company, 1970.

Johns, E. and D. McC. Fraser. "Social Studies Skills: A Guide to Analysis and Grade Placement," Skill Development in Social Studies, H. Carpenter (ed.). Washington, D. C.: National Council for the Social Studies, 1963.

Lippitt, R., R. Fox, and L. Schaible. Social Science Laboratory Units. Chicago: Science Research Associates, 1969.

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V. Specialized Skills

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A TAXONOMY OF COGNITIVE SKILLS:
The Application Of The Higher-Order Cognitive Taxonomy To Realia.

Operating with an expanded taxonomy derived from the models collected in the search of curriculum theory literature, a selection of innovative skill-based instructional material was analyzed with the goal of expanding and refining the HOC taxonomy. It was hoped that by identifying what is taught across a variety of materials and by classifying these objectives and activities according to an exhaustive taxonomy of cognitive processes and skills, it would be possible to identify the skill areas that are untreated by current materials.

The analysis that follows is a classification of cognitive activities and objectives of sixty-three innovative instructional programs. The programs were sorted according to the following taxonomy:

HIGHER ORDER COGNITIVE SKILLS TAXONOMY

I. Learning to Learn Skills
   - Attending and Orienting
   - Decoding
   - Memorizing
   - Studying

II. Communication Skills
   - Observing
   - Describing
   - Explaining
   - Discussing

III. Classifying and Comparing Skills
   - Differentiating and Grouping
   - Classifying
   - Ordering
   - Comparing
   - Using Numbers

IV. Synthesizing and Producing Skills
   - Inventing
   - Associating
   - Elaborating
   - Generating Implications
   - Planning
   - Solving Problems Using Strategies

V. Skills of Judging and Inferring
   - Coding
   - Judging
   - Inferring
   - Testing

VI. Skills of Value Analysis and Decision Making
   - Valuing
   - Evaluating
   - Deciding

At this stage, it should be useful to identify the constraints that went into the analysis:

1. Only currently available elementary school curriculum materials were selected.

2. The program had to be oriented towards cognitive or intellectual skills or "process education."

3. The material had to be accompanied by instructional objectives (in a few cases, the objectives were provided by some independent source).

With these constraints, science, math, English and social studies materials were included only if their major emphasis was on teaching the skills of research and problem solving in those areas. Curriculum materials dealing strictly with knowledge or concepts, and organized in that manner, were excluded from the analysis.

Sixty-three educational programs were selected for inclusion in the analysis. Nineteen were early childhood curricula, four of which were programs oriented towards some specific skill area. Seven were science curricula; six were social studies curricula; one was a math program and one other was a science and math program. The remainder were innovative skill-oriented programs that could not be classified under traditional subject matter headings. In addition to the sixty-three programs, four documents which offered a glossary of objectives and activities were included in that they were designed to instruct teachers in building a skill-based curriculum.

This analysis provides documentation of curricular needs, exposes the lack of sequenced, hierarchical, skill-based curricula and invites comparisons between instructional programs within and across grade levels. Despite its value as a guide for the developer of innovative curriculum, the following ambiguities and discrepancies should be pointed out:

1. The ideal analysis would have consisted of a separate taxonomy of cognitive skills for each grade level; however, this was found to be an impossible task. Some materials were recommended for a specific age group while some contained recommendations for a sequence of instruction over a range of ages. The more common case, however, was that the materials were recommended for an age range, e.g., early childhood.

2. The ideal result of this analysis would be a continuum of cognitive skills. That is, instead of three taxonomies (classifications), the taxonomies would be integrated such that hierarchies would emerge within and across specific skill clusters. Instruction in memory skills would proceed from simple prerequisite skills to complex, more differentiated skills. Skills taught in isolation in early grades, e.g., listening skills, would be taught in conjunction with other skill areas in the later

grades, e.g., listening skills with critical thinking skills. Again, this kind of organization could be imposed upon the analysis only with great risk to its validity. Only a few of the instructional programs were based upon a hierarchical model of instruction.

3. Some skill areas are not represented. Insofar as the working definition of "higher-order cognitive skill" necessitates that the objective under analysis require some transformation or translation of input, traditional reading, penmanship and grammar programs were not included in the analysis. Critical reading skills, reading and composition skills and semantic analysis skills were, however, included.

4. Subject matter areas tend to be represented to the extent that skill-based performance objectives were included with the materials. As expected, science programs were found to contain performance objectives more often than other programs. A high percentage of mathematics curricula were also found to contain performance objectives; however, because the Higher-Order Cognitive package staff had made the decision to restrict the analysis to mathematics problem-solving programs, only two math projects were included.

5. The sorting process, which involved six components or classes of cognitive processes and twenty-six processes or skill clusters, became a bit unwieldy at times causing some very arbitrary classifications. For example, science units which involve the coordination of skills in making operational definitions, controlling variables and generating hypotheses were classified solely under the Component V subset of "Testing." A great variety of critical thinking skills were classified under "Judging," but the distinction between "Judging" in Component V and the subset of "Listening skills requiring responses" under Component I was difficult to preserve. Map and globe skills were classified under Component I, II, or IV depending upon the emphasis of the unit. In summary, our classification scheme turned out to be quite useful, albeit imperfect.

The analysis allowed a number of interesting implications and conclusions:

1. A number of skill-oriented programs are offered for the early childhood grades. There seems to be more attention paid to providing for the facilitation of a broad set of skills in these years than in any others. In addition, there is a heavy emphasis on learning-to-learn skills in the early years.

2. There is a paucity of good skill-based instructional material available for the middle elementary grades (3-4) in all areas save creative expression.

3. While there are many programs which purport to deal with problem solving, very few of them are skill-oriented and fewer still contain skill-based objectives in creative problem solving or critical thinking.

4. Although a number of experimental programs can be found which attempt to teach affective expression, there are almost no programs which are oriented towards teaching skills of value analysis and decision making.

5. Perhaps the most important finding is that with one, perhaps two, exceptions, no curricula exist which include a continuum of skill instruction across grades. The great majority of the programs included in this analysis are either for one grade level, or, if they include material for more than one level, no attention is paid to devising learning hierarchies. One of the exceptions, *Science: A Process Approach,* is built upon a hierarchical model of instruction within and across grade levels. Students learn simple observation skills, classification skills, etc., in the early grades and then learn more complex skills in these areas in later grades. In addition, as you go up in grade level, these skills begin to build upon one another such that in the later grades, fifth and sixth, more complex skills made up of an integration of prerequisite skills become the center of attention.

This analysis engendered a variety of impressions concerning available curriculum materials. For someone interested in developing materials with the idea of fostering cognitive skills in elementary school students, grades 3-6 offer an almost untapped area. Yet some excellent guidelines are offered by such exemplary programs as *Science: A Process Approach; Man: A Course of Study; Science Curriculum Improvement Study; SRA Basic Skill Series; The Productive Thinking Program;* and *Social Science Laboratory Units.* The vast majority of curriculum material for the elementary grades is concerned exclusively with what might be termed, instrumental skills of reading, writing and arithmetic. More recently, this basic skill core has been expanded to include skills of scientific inquiry.

Among the skill areas identified by the Higher-Order Cognitive component as receiving less than adequate emphasis by existing programs are the:

1. learning-to-learn skills of using mnemonic strategies for memorizing and learning and using problem-solving strategies for inquiry
2. communication skills of reporting descriptions and explanations and conducting discussions
3. analytic skills of using strategies, diagrams and classification schemes to solve problems
4. production skills of planning
5. creative problem-solving skills, especially generating implications
6. critical-thinking skills of coding, assessing statements, inferring and testing
7. skills of decision making.

What is needed, of course, is to determine a way to:

1. generate operational definitions for these skills and for their relevant subskills
2. determine the optimum level at which these skills need to be introduced into the curriculum
3. determine the optimum sequence for training these skills
4. generate vehicles or topics for illustrating and practicing these skills
5. determine methods for evaluating the effects of instruction in these skills.

To this end, the Higher-Order Cognitive component of the Humanizing Learning Program of Research for Better School has initiated plans for development of a wide range of curriculum materials. A preliminary set of materials designed to teach the skills of Component V, critical thinking and problem-solving skills, is currently under development.

The instructional materials analysis which follows is divided into three grade-level sections—preschool to second grade, grades 3 and 4, and grade 5 and beyond. Within each group, the skills taught by the reported materials have been assigned to the appropriate sections of the HOC taxonomy. Therefore, all analyzed materials which teach a corresponding HOC taxonomy skill are grouped together as are, for example, the six programs which teach the skill of "decoding" on the preschool to second grade level. One program may be catalogued on several different pages under different HOC categories, for example program (14), the Early Learning Curriculum, teaches HOC skills of "decoding," "describing objects and systems," and "planning," among others. The numbers appearing in parentheses on the chart are keyed to a list of curriculum materials which appears after the charts.

I. LEARNING TO LEARN SKILLS — Level: Preschool to Second Grade

A. Attending and Orienting

1. Following Directions
   - task completion, persistence (14)
   - giving directions, focussing attention (14)(29)(7)(37)(*iv*)
   - interpreting directions for mood, humor (29)(7)
   - impulse control, competition, social skills (14)
   - names and responds to locomotor movements (4)
   - enunciates, repeats sentences (4)

B. Decoding

1. Auditory Decoding
   - a. Auditory Discrimination — pitch, intensity, types of duration, direction, distance (14)(13)(37)(*iv*); matching instruments that sound alike, generating rhymes, echoing stressed words (4)
   - b. Auditory Recognition — difference in word sounds, number of syllables (13) rhymes, endings, beginnings, poetry, pronouncing (13)(51)
2. Visual Decoding
   - a. Visual Discrimination — shape, color, size, position orientation (14)(61) naming objects, pictures (4) design matching (3) recognition of representations, recognition of symbols (13)(19)(36)
   - b. Spatial Relations — figure ground, perceptual constance, position in space, perception of spatial relations, terms for (19)(61)(28); uses words, foreground and background (4); identifies whether form will fit in mold, in complex diagram (3)
   - c. Visual Comprehension — labelling objects, pictures, finding hidden figures, discriminate parts from the whole, labelling detail (33); labelling sequence, figure completion, identifying shapes (13); associating names to pictures, inferring sequence, consequences (61)(2)(3)
3. Tactile and Cross Modal Decoding
   - a. Tactile Discrimination — texture, shape, temperature (14)
   - b. Cross Modal Discrimination — cross modal discrimination (14)

C. Memorizing

1. Visual Memory
   - a. Labelling — labelling pictures, recalling pictures, reproducing sequence, name missing parts, events (14)(33)
   - b. Memorization — figural memory (37)
2. Auditory Memory
   - a. Memorization — memorizing poems, rhymes, songs, word series, addition, recalling details from a story, digit span, associative recall (14)(33)(28)
   - b. Memory Span — coding skills (14)
   - c. Mnemonics — strategies for memorizing rhymes, serial ordering, clustering pegs (14)

D. Studying

1. Comprehension Skills
   - a. Language Mediators — formulating questions, asking appropriate sources, rejecting irrelevant information, reading (14)
   - b. Listening Skills — sequence events in stories (*i*); differentiating fact from fiction, recognizing dialect, criticizing stories, listening for details, main ideas (*iv*)
   - c. Information Interpretation — cartoon appreciation, map reading (*i*); critical discrimination skills, meaning of common symbols (5)
2. Production Skills
   - a. Information Locating — using library, skills of interviewing (*i*)(5)
   - b. Information Organizing — making a collage, oral report (5)
   - c. Communication Skills — reports (*i*)

I. LEARNING TO LEARN SKILLS — Level: Third and Fourth Grades

A. Attending and Orienting

B. Decoding

1. Visual Comprehension
   - a. Interpreting Pictorial Material — interpreting pictorial material (*ii*)

C. Memorizing

D. Studying

1. Listening Skills
   - a. Language Skills — spelling, vocabulary, pronunciation, oral reading (*iv*)
   - b. Listening Comprehension — identifying sequence, details (*iv*) main ideas in stories, generating plot titles, inferring conclusions, relationships, recognize unsupported ideas, emotionalism (*i*)(51)
2. Information Locating
   - a. Reference and Library Skills — knowledge of library (*i*)
3. Information Interpretation
   - a. Using Maps and Globes — rules for use of scales, symbols, finding distances, inferring from maps, cardinal directions, compasses, parallels and meridians, map projections (*ii*) determining directions, locating places, composing maps (31)
   - b. Using Chronological Concepts — using the calendar, time system (31)
4. Information Organizing
   - a. Classifying or Sequencing Information — paper writing techniques (31) cataloging, sequencing pictures and information (60)
   - b. Outlining and Notetaking — notetaking skills, keeping a notebook, techniques of outlining -- articles, speeches, movies (*iv*)(*i*)(60)

I. LEARNING TO LEARN SKILLS — Level: Fifth Grade and Beyond

A. Attending and Orienting

B. Decoding

1. Visual Decoding

a. Interpreting Pictorial Material	interpreting pictorial material (45)
b. Interpreting Cartoons	identifying symbols (45) point of view (*i*)

C. Memorizing

D. Studying

1. Listening Skills

a. Listening Comprehension	summarize, note central ideas, characters, setting (*i*)
b. Critical Listening Skills	identify emotionally laden words, prejudice, detect influence in voice and gesture, evaluate evidence (*i*)

2. Information Locating

a. Reference and Library Skills	using encyclopedia, diagrams, newspapers, magazines, field trips, Reader's Guide (45)(50)(31)(*ii*)

3. Information Interpreting

a. Interpreting Charts and Graphs	use SQ3R method, subheading (*i*)
b. Using Maps and Globes	direction, distance, routes, relief (50)
c. Strategies for Studying	interpret diagrams, tables (45) linegraphs, pie charts (50)(*ii*)

4. Information Organizing

a. Outlining and Notetaking	key words, use of who, when, where, what, how (51) take notes from passage, construct outline from notes (50)(*ii*)
b. Summarizing and Reporting	identify parts of report, function and put them in sequence (51) extract extraneous ideas, recognize and write paragraphs, detect repetitious language (*iii*)(50)(*i*)

II. COMMUNICATION SKILLS — Level: Preschool to Second Grade

A. Observing

1. Skills of Reporting (concepts & vocabulary)

   a. Object Properties — color, shape, texture, size, temperature, sound, odor, type (46)(47)(42) odor, taste, sorting objects by property, property change (34) drawing shapes, using formboard (8) solids, liquids, plant parts (42) names shapes and functions of objects, separates by color, by touch, by shape, by arbitrary property, by taste (4)

   b. Systems and Physical Phenomena — temperature, sound, weather, magnets, plant growth (46)(5) flashlights, magnets, seeds, color mixing (34)(42)(3)

   c. Behavior — animal motion, responses (46)(5) copying motion, drawing motion (5)

2. Process of (visual decoding):

   a. Relationships and Relativity — relative sizes, cues, relational prepositions (11) patterns, symmetry, angles, shadows, distance (42) position and perception, bias, meaning and observing (58) discrimination between observation and assumption (60)

   b. Strategies for Data Gathering — experiments with changing properties posing questions, problem-finding (34) identifying objects in an array: 20 questions, probability, ranking, search, strategies for missing objects (14) uses affirmative or denial statements in identifying objects, describing (4)

   c. Reporting Sensations — using several senses (46) guessing contents of mystery box (5) reporting on a field trip (5)(3)

B. Describing

1. Describing Properties

   a. Shapes and Patterns — identifying, describing, drawing and forming simple geometric shapes and patterns (34)(3) introduction to geometry (46) identifying spacing arrangements, components of shape, describing symmetry (46) beginning classification - shapes (4)

   b. Objects and Systems — identifying properties for descriptions, describing pictures(7) identifying function and location of objects, classifying with a given criteria, give description (14) using locational words (38)(60)(58)(37)(4)

2. Using Space/Time Relations

   a. Location and Position — describe a location by its objects, by position, describing a route, name all points with 2 dimension, 3 dimension, field trip (14) using angles, area proportions, describing location with maps, map reading, using locus and frame of reference (34)(46)

   b. Temporal Relations, Events — telling time (46) ordering events, using time words, time relational words, time periods (38) time intervals (46) telling stories in time order, time and maps and globes (13) describing movement (46) seasons (8) describes his activities relative to time of day (4)

3. Describing Affect

   a. Sensations — describing past events by describing sensations, future events (14) describes events and how he feels on coming to school (4)

   b. Emotions — describing feelings and emotions (14)

C. Explaining

1. Describing Sequence and Causation

   a. Systems — describing stages in life cycles, human growth, physical changes, collisions, plant growth (46) color mixing, light mixing, money system (3) causal vocabulary for descriptions (29)

   b. Events — traces a chain of events, infers, explains relationships (29) explains functions of institutions of community (29) child uses because statements to finish unfinished stories, to respond to questions (4)

II. COMMUNICATION SKILLS (continued)

Level: Preschool to Second Grade

2 Using Causal Terms

a. Skills of Predicting — anticipates dangers (29) predicts occurences, demonstrates predictions (57) predicts results of growth, decay, manufacture, waste (13)

b. Simple Experimentation — describes simple experiments, describes interaction, hypothesizes (47) physical and interpersonal outcome hypotheses (13)

D. Discussing

1. Reporting, Summarizing and Persuading — persuades someone to do something, proves a point, provides examples, provides clarification, gives reasons for statements (14) translates, defines words to peers, gives directions, shows operation to others (29) summarizes events, reading, operation (5)(3)

2. Skills of Group Discussions and Debates — takes part in group discussion, role play, silent discussion (29)(*i*)

II. COMMUNICATION SKILLS — Level: Third and Fourth Grades

A. Observing

1. Skills of Reporting (concepts & vocabulary)

a. Systems and Physical Phenomena	life systems: plants, effects of moisture, temperature, light (34)
b. Behavior	life systems: animals (34) character development in stories (22) microbes, pets and temperature changes, stages of development (5)

2. Process of (visual decoding):

a. Relationships and Relativity	reference frame, positional bias, relativity, position and motion (47) discriminate observations from assumptions (60) identifying shapes from different relations, identifying patterns and objects from blueprints (8)
b. Reporting Sensations	reporting on personal observations of neighborhood (21) using all the senses (21)

B. Describing

1. Describing Properties

a. Parts and Wholes	describing objects, details (60) describing objects from different points of view, compering descriptions (58) definitions through description, aesthetic, explanatory descriptions (58)

2. Using Space/Time Relationships

a. Position and Motion	description by using polar coordinates, rectangular coordinates, angles (47) forces, motion, rotation, angular speed (46)
b. Temporal Relations, Events	describing operations, motions (*i*) using rules for time relation words, describing sequences, describing direction (51) time growth, logical sequence (58)

C. Explaining

1. Describing Sequence and Causation

a. Systems	batteries, electricity, magnetism (15) compasses, magnets (47)
b. Events	making explanations for historical events (53)

2. Using Causal Terms

a. Making Logical Explanations	logical criteria for explanation, discriminating relevant from irrelevant causes, use of generalizations (53)(58) six methods of explanation (58)

D. Discussing

1. Reporting and Summarizing

	summarizing, storytelling (*iv*)(5) formulating conclusions (31) presenting information graphically, dramatically (31) making oral reports (*iii*)

2. Skills of Group Discussions and Debates

	panel discussions, interviewing, committees, dramatization (*iv*)

II. COMMUNICATION SKILLS — Level: Fifth Grade and Beyond

A. Observing

1. Reporting on Observations — cartoon analysis, inferring, recognizing implications (nil) discriminating observation reports from assumptions (60)
2. Conducting Observational Studies — collecting behavior specimens, demonstrate ways of making valid observations, discriminating between observations, inferences and value judgments, producing behavior specimens (49)

B. Describing

1. Skills of Composition Writing — making efficient descriptions, aesthetic, definitive descriptions (58)
2. Map Reading Skills — describing land routes, describing flights (45)

C. Explaining

1. Using Different Types of Explanation — giving opinions, indicating a procedure, using definitions, making evaluations, drawing conclusions, drawing comparisons, making descriptions (58)(51) identifying circular causations (49)
2. Inquiry Skills — generate circular causation, resolution of, analyze behavior specimens, demonstrate causation in behavior, use inquiry techniques to discover causes for social problem (24)

D. Discussing

1. Summarizing — current events summary, decision tree (5)
2. Skills of Group Discussions — skills of being participant, leader, knowledge of 8 flaws in discussion (58)

III. CLASSIFYING AND COMPARING SKILLS — Level: Preschool to Second Grade

A. Differentiating and Grouping

1. Broad Conceptual Categories — groupings based upon feelings, roles (13) animals, playthings, clothing (11)(38)(37) grouping objects in 2 different ways, picture sorting (3)

2. Relational or Functional Properties — grouping objects with the same function, attributes parts (58)(13)(29)(38)(5)(37) grouping by use, by position, matching (11)

3. Descriptive or Perceptual Qualities — figure sorting task (3)(29) size, shape, color (38) texture (3)

4. Alphabet or Vocabulary Groupings — sorting cards by numerals, letters, symbols (3) sorting alphabet sounds, word functions, endings (36)

B. Classifying

1. Multiple Classification and Matrices — logical classification: develop a concept deductively, modifies concept with new information (29) one dimensional sorting with or without noisy attributes, 2 and 3 dimensional sorting, matrices, hierarchical sorting, using disjunctive classes, describing a classification system (14) concept of set and grouping (34) multiple classification (26) refining a classification, oral to written classification, outline form, classification for pictures (44)(28)(13)

2. Using Classification Skills — defending self generated classification schemes (60) classification of books, trees, animals, letters, numerals, shapes (3) leaves, nuts, shells, animals, living and non-living things, aquarium, organizing colors, solids, liquids and gases, materials and mixtures (46) biological concepts, living and non-living things (47)

C. Ordering

1. Seriation and Geometric Skills — pattern completion (3) identifying shapes, line relationships, construction of shapes, forms, seriations, matrices, predicts fit of forms, next objects in seriation (14) serial ordering, judgment of greater, less, equivalence (26) ordering sets of objects by size, weight, color, matching sets of ordered objects (29) completion of figural progressions, identifying items to produce equivalence (3)(13) arrange figures in a seriation, identify missing figure in a trend (3)

2. Time Order, Sequencing Skills — arranging pictures of facial expressions, arranging temporal order pictures (3) classifying ways of measuring time (5) conservation of area, volume (14) identifies sequence and faulty sequence, using before, after, tomorrow, arranging (29) pictures, story segments in sequence (77)(44) identifying what happened before in a series, sequencing action pictures, generate end of sequence (3)(13)

D. Comparing

1. Equivalence, Conservation, Class Inclusion — evaluating one-to-one correspondence, food/people (3) conservation of amount (34) demonstrates one-to-one correspondence, cardinal value, equal units, reversibility conserves equality (29) class inclusion problem, problem-solving with categorical exclusion (62) matching, to sample with or without noisy attribute, oddity problem using examples (14)

2. Discriminating and Defining — identifying similar designs, symbols, letters, rhymes vs. non-rhymes, generating synonyms and antonyms (3) compares conceptual and functional properties: animals, geography, cooking utensils, binary comparisons, same order-different position, size, up or down, in or out (11)(2) finding and generating similarities and differences, train and airplane (60) for a series of pictures, for time periods, products, stories (5)

3. Measuring — using appropriate size words (4) weight (3) compares sizes with big, little, quantities with number, qualities with texture (38) direct comparison, mediated comparison with standard objects, with marks, with standard units (14) comparing lengths, volumes, linear with metric units, using a balance ordering, figures by area, comparing forces with springs, using scales, temperature, volumes (46) non-numerical measuring, with reference units, comparing changes, experimentation (34) comparing length plants, ordering lengths, dividing length into segments, measuring length, comparing, ordering, dividing area, weight and volume (42)(36)(13)(14)

III. CLASSIFYING AND COMPARING SKILLS (continued) Level: Preschool to Second Grade

E. Using Numbers

1. Counting Skills

using sets, numerals, order, number line, using 0-99, addition of positive integers, multiplication (46) counting, recognizing and writing to 20, discriminating, odd and even counting up from x to y (36) sets operations, equations, fractions (14) addition, subtraction, multiplication, division, fractions (34)

2. Problem-Solving Skills

using a tally chart to identify number of instances of an event (4) ordering properties, comparing volume with numerals, tally marks to represent objects in a set (34) one-to-one correspondence (34) scaling and representation, construction of a scaled model (34)

III. CLASSIFYING AND COMPARING SKILLS — Level: Third and Fourth Grades

A. Differentiating and Grouping

1. Learning Classifications — grouping words, attributes, objects, sentences, e.g. by function (58) identifying p[illegible]e, direction, chronology, membership, synonym, predication, comparison, serration, order, sequence in a communication (58) defining meaning by context, differentiating meaning by order, pattern, correspondence, context, modifying words (58)

B. Classifying

1. Qualifying (language skills) — animals according to commercial use, governments, rules of phonics (5) materials (46)(34) natural systems (34) types of measurement (5) geography (5) numbers, fractions, decimals (5)

2. Generating Classification Scheme — inventing means of classifying shapes, objects (9) using who, what, where, when in reading (5) self-generating categories for literature analysis, defending classification schemes (60) multiple classifications (53)

3. Classifying as Problem-Solving — using a classification scheme as a research tool (*iii*) using inquiry techniques to classify unknown objects (24) classification games (15)

C. Ordering

1. Time Order, Sequencing Skills — ordering attributes on perceptual characteristics or complexity, on chronology, on direction, generating narration (58)

D. Comparing

1. Discriminating and Defining — describing similarities and differences, e.g. birds, butterflies, qualifying comparisons when data is not valid (60) fictional characters, seasons, countries, plants, animals, appliances (5) comparing on stated criteria (5) breaking down assumptions in comparing things with the same name (21)

2. Measuring — recognize perceptual illusions, increase measuring efficiency (21) measuring angles, units of force (46)

E. Using Numbers

1. Counting Skills — multiplication, numbers and their properties (34) decimals, large numbers (46)

2. Problem Solving Skills — using computers, graphs, making changes (34)

III. CLASSIFYING AND COMPARING SKILLS — Level: Fifth Grade and Beyond

A. Differentiating and Grouping

1. Qualifying (language skill) — concepts of composition (58) functions of words, use of symbols, varieties of meaning (63)

B. Classifying

1. Using Classification Schemes — foods, elements, color, astronomy, architecture (5)

C. Ordering

1. Problem Solving as Ordering — steps in inquiry, problem solving, decision making, ordering problems to be solved, problem solving in mathematics: approximating, estimating by interpolation, checking answers, working backwards (40)

2. Using Diagrams for Logical Thinking — diagrams for class inclusion, problem, logical sense problem, probability, matrices, Venn diagrams, circles for syllogisms, imagining changes, number line areas, using maps, visualizing motion, branching diagrams, branch classifications networks, decision making as branches (40)

D. Comparing

1. Discriminating and Defining — forms of travel, life style, governments, political structure, candidates, fictional characters (5)

2. Measuring with Charts, Graphs and Maps — using maps, scale, graphs, diagrams for mathematical problem solving (40) measuring small things (46) using graphs and charts (5) measuring distance and scale direction, comparing and decoding rainfall maps, relief, describing flights, telling time with maps (45)

E. Using Numbers

IV. SYNTHESIZING AND PRODUCING SKILLS

Level: Preschool to Second Grade

A. Inventing

1. Designs and Graphics

constructing two different shapes by adding lines to given lines, producing two objects from combination of given figures, arrange geometric shapes to make two faces, invent meaning for scribble drawing by illustration (3) generate an idea for an alternative to an umbrella (3) generating ideas to make the classroom better (3)

2. Ideational Fluency

ideational fluency (35) participate in a simple brainstorming session (3)(33)(37)(29) ways of using large pile of stones (3) new uses for objects (29)(14) possible function for mystery objects (14) generate substitutions for functional objects (3) problem finding (36) generating objects for categories (33)

3. Strategies for Idea Generation and Inquiry

question asking strategies (36) search strategies: information and objects (14) brainstorming (3)(37)(29)

B. Associating

1. Associational Fluency

associational fluency (24) teaching strategies (35) tell two ways to play with ball, three properties of three things, generate synonyms, antonyms, free associate to the color red, tell ways two objects are alike, two pictures, two meanings for a word, two homonyms, two figures, generates things that come in pairs (3)(33) would you rather be an x or a y (21) identifying opposites in pictures, expressions (3)(33)

2. Analogical Reasoning

identify completions of figural analogies (3)(14)(44) picture word analogies, word-word analogies (44) complete a semantic relationship in a matrix, pictured relationship, generate missing picture (3) complete remote associates, generate word that stands for two things (3) simile generation (4)

3. Reasoning by Association

problem solving using newly learned principle, expressing new idea by relating it to old one, use remote associates for problem solving, relates an object to two or more classes (29) given solution to one problem, generate new problem where it is applicable, identifies problem elements (14) classifying pictures by associating detail with persons, carpenter with tools (33)

C. Elaborating

1. Creative Expression, Fluency and Originality

creative expression, fluency and originality (35) answering creative questions (33)(4)(21) story titles dramas (29) picture description, story creation, riddles, story endings, making a diary, games, e.g., object description by giving clues (33)(21) rearranging words to make sense, generate names for a drawing, breaking concepts: when a house is not a home, simile completion (3)

2. Dramatic Expression and Humor

dramatic expression and humor (35) produces a joke: overstatement, incongruity (29) role playing, rhyme recitations, dramatic stories (33) pantomime, motor responses to pictures, acting out descriptions (19) generating a story appropriate to a musical piece (4)

D. Generating Implications

1. Generating Causes and Consequences

predicting difficulties, dangers in using materials (14) generating consequences for physical structures, blocks (4) identifies problem displayed by pictures, generates conclusion (4) consequences for social situations, changes (3) stating actions occurring before a given picture(3) guessing causes, consequences (what) would happen if (21)

2. Imagining Future Events and Role Playing

imagining future events and role playing (36)(35) what would you do if . . . problems (60)(33) e.g., lost in a strange city (5) reporting imagery (33) discussion of future events, imagining future events (62)(37) just suppose (21)

IV. SYNTHESIZING AND PRODUCING SKILLS (continued) Level: Preschool to Second Grade

E. Planning

1. Structures and Designs	direct copying, one, two, three dimensional patterns, copying involving translation, extending resource patterns (14) planning a block structure, map, floor plan, structure from a map (29) paths through mazes (3) building houses (2)
2. Activities and Operations	plan trips and parties, reviewing alternatives, school activities, story telling (5) using imagery in planning, maps, itineraries (36) group work to solve class problems: assign roles, etc. (3)

F. Solving Problems Using Strategies

1. Generating Alternative Solutions	steps in problem solving: definition, characteristics of a solution, alternatives, evaluating guesses (36)(*iii*) information locating strategies used in problem solving, collecting evidence (*iii*) generating possible solutions to problems (e.g., what shall class project be) (60)(5)
2. Formulating Hypotheses and Predicting Outcomes	beginning probability, predicting outcomes, if *x* were true, what would happen (14) surveying opinion, using graphs (46) simple physical experiments with predictions (3) (46) transferring from previous problem solving activity to new one: student predicts outcomes under changing conditions (*iii*)

IV. SYNTHESIZING AND PRODUCING SKILLS

Level: Third and Fourth Grades

A. Inventing

1. Designs and Graphics — inventing new objects, figures from given items, invent new signs and symbols (9)
2. Ideational Fluency — improving upon a game, animals, products, flowers, new uses for bottles (9)(35)

B. Associating

1. Associational Fluency — associational fluency (35) generating similarities between things, two or three at a time, identifying relationships (21)(22) generating similies, free association, e.g. round things, word chains, associations to shapes, making a code, homonyms, antonyms (9)

C. Elaborating

1. Creative Expression, Fluency and Originality — cartoon captions, plot titles, story completion, making pictures, designs, sculptures, pictures out of parallel lines, word pictures (9) recalling unusual names, stories, titles (21) describe what sounds suggest, images to sounds (22)

D. Generating Implications

1. Generating Cause and Consequences — imagining hypothetical situations: causes, consequences, plans, problem solving (21) what would happen if ... problems (21)

E. Planning

1. Structures and Designs — building model bridges, planning structures, predicting results (15) making a model city block, collage of neighborhood activities, graphs (39)
   a. Map Making — map making (*ii*)(34) mapping games, scale models, using symbols, compasses, enlargements, grids, scale transformations, elevations (15) map of city, classifying businesses, residence areas, self-generating symbols (39) drawing routes, using coordinates, using knowledge of terrain, temperature, directions to construct a map (45)
2. Projects and Projections — planning a new city, generate questions to be asked, problems to be solved (9)(21) discussion of possible solutions to problems in science, history, geography, language arts (22)(21) planning for solution to class related problem (45)(5) personnel management for class project (5) using fantasy to solve problems (21)

F. Solving Problems Using Strategies

1. Social Science Investigations — interviewing, use of charts and bargraphs (39) twenty questions method (21) generating alternatives to social problems (22)(31) systemic reasoning -- describing and seeking solutions to problems with no right answers, multi-causal, multi-variate, multi-consequence problems (60)
2. Experimental Design — observation and hypotheses (46) data interpretation (46) (53) generating multiple hypotheses (21)

IV. SYNTHESIZING AND PRODUCING SKILLS — Level: Fifth Grade and Beyond

A. Inventing

1. Strategies for Ideational Fluency

   using direct analogies, functional analogies, identifying new ways to look at problems (52) identifying sequence of the inventing process (52) introduction to brainstorming, role playing, collages (20)(35)

2. Ideation Strategies for Creative Problem Solving

   extended effort principle, free association, synectic techniques, analogy, brainstorming, part changing method, checkerboard, borrowing, Osborne checklist, morphological analysis used in problem solving (59)(43) attitudes of creative problem solving (43) exercises in insightful thinking, sequential thinking, strategic thinking (18)

B. Associating

1. Associational Fluency

   associational fluency (35) making bizarre comparisons: how is a chair like a boy (52) comparisons in science (52) describing similarities, explaining relationships (21)

C. Elaborating

1. Creative Expression, Fluency and Originality

   creative expression, fluency and originality (35) story completion exercises (59) creative responses to recorded material (51) describing what sounds suggest, images to sounds (22) plot titles, describe original movie plot, sentence writing using given words, cartoon completions (23)

D. Generating Implications

E. Planning

1. Projects and Projections

   reviewing alternatives relative to school, home activities, making diagrams and maps to display alternatives (5) making a model of community, making a collage, group planning of class projects (39) planning a class trip, selecting panels for class discussions, making time budgets (5)

F. Solving Problems Using Strategies

1. Heuristic Strategies

   skills of problem recognition, formulation, information organizing, idea generation and hypothesis testing, strategies of planfulness, persistence, set changing, idea checking (43)(30)

2. Research Tools and Strategies

   historical research, graphing trends, descriptive research: mean, mode, median, standard deviation, tally marks, research design, tables (54) diaries, bar graphs, pie charts, maps (45) maps, collages, classifications, interviews, questionnaires, charts of geographical composition, bar graph of occupations, pie charts of ethnic composition for study of cities (39)

V. JUDGING AND EVALUATING SKILLS — Level: Preschool to Second Grade

A. Coding

1. Using Evaluative Words

using and responding to "not" statements, using polar opposites, relational propositions, using negative instances and positive instances, simple if - then deductions (7) identifying errors in use of all, everybody (5) defining terms (36)(3)

B. Judging

1. Assessing Statements Using Logical Criteria

generating true and false statements, criteria for judging (36) assessing the news, TV propaganda (5) supporting statements with evidence (60) examining claims by checking evidence, discovering fallacies in advertising (60) generate bases for like-dislike statements (60)(37) seeing paradoxes in genralizations, all x's are y's, detecting errors in statements, judging what word does not fit with others, explaining why statements are non sensical, detecting sentences that do not belong in a story (3)

a. Looking for Assumptions

questioning validity of information sources (5) distinction between describing observations and what is assumed, distinction between assumption, guess, and fact (60) reading stories, separating fact from fiction, determining conditions that could make something true.

2. Evaluating According to Pragmatic Criteria

recognizing the correct pattern, detecting errors of sequence, errors of causal reasoning (36) evaluating advertising characteristics of a good ad, tallying types of ads relative to given criteria, evaluation of visual appeals (41) judging speeches by length, voice, content, form of presentation, judging pictures relative to appropriateness to some criteria (5) given pictures, records, oral information if statements are true or false (60) evaluating items that don't belong, e.g. in pictures, evaluate appropriateness of tools for functions, choose objects that best fit descriptive criteria, selecting pictures that are most suitable to criteria (3)

a. Judging Solutions

strategies for generating solutions, ranking alternatives and stating conditions under which a given solution could apply, generating criteria (14) determine if data, conclusions are relevant to the problem at hand (36)

C. Inferring

1. About Objects

inferring the contents of a package from size and shape (4) inferring from pictures by using clues, inferring from maps (2) mystery boxes (48) differentiating between similar things through inference (46) the characteristics of packaged articles (46)

2. About Events

inferring about human growth (2) inferring events from pictures, form and context from reading, from reading and pictures, doing crossword puzzles (44) inferring sequence from 2 or 3 related events, inferring what could have happened before, judging what will happen next from pictures (11)

D. Testing

1. Inference and Hypotheses

trying out inferences, or problem solutions on a range of related problems, trying out solutions on an original problem (14) testing hypotheses about plants and earth science (5)

V. JUDGING AND EVALUATING SKILLS

Level: Third and Fourth Grades

A. Coding

1. Interpreting Word Usage

interpreting mood, dangerous words, imagery, distortion phrases, loaded words, advertisements, vivid words (*iv*)

B. Judging

1. Assessing Statements Using Logical Criteria

discriminating between opinion and fact (5) judging the reliability of statements (21) distinguishing fact from fiction (*ii*) criticizing superstitions, errors in observation (21) analyzing thought habits (5) using like-dislike statements to discriminate relevant from irrelevant facts (60)

   a. Looking for Assumptions

learner should give evidence to support his claims or recognize the assumptions made (60) recognizing assumptions in a story (5)

2. Evaluating According to Pragmatic Criteria

evaluating reasons for different room arrangements (5) deciding on purchases, recognizing the more important criteria (21) compare prices of products, name brands with others, evaluate effect of stamps, categorize appeals (41)

C. Inferring

1. Physical Systems

observations and inferences (46) tracks and traces, displacement of water, loss of water by plants, electrical circuits, shape of cut things (46)

2. Events

determining if the data of an experience supports a particular interpretation (60) recognizing the difference between an implication and an inference, especially in literature where reader draws inferences from implications (*iii*)(21) inferring, generalizing from evidence (*ii*)

D. Testing

1. Inferences and Hypotheses

testing inferences about climate, doing research to test inferences (5) the nature of proof, backing up inferences with evidence (21) applying problem-solving and central thinking skills to social issues (*ii*)

2. Testing Using Experimental Methods

   a. Formulating Hypotheses

observation and hypotheses, conductors (46)

   b. Defining Operationally

electric circuits, analysis of mixtures, cells and living things (46)

   c. Controlling Variables

rolling cylinders, movement of liquids, mold, loss of moisture (46)

   d. Interpreting Data

guinea pigs, analysis of mixtures, precision in measurement, interpretation of field of vision (46)

V. JUDGING AND EVALUATING SKILLS **Level:** Fifth Grade and Beyond

A. Coding

1. Words

identifying words used to judge, imply, qualify (60) multiple definition (60), recognizing words used to influence impact of words (63) distinguishing between denotation and connotation, recognizing power of words (55)

2. Symbols and Abstractions

recognizing symbols, discriminating between the symbol and the thing (63) identifying levels of abstraction, use of classification for meaning (55)

B. Judging

1. Critical Reading Skills

distinguishing fact from opinion (51)(*iii*)(*ii*) describing authors purpose, point of view, research evidence, make judgments on validity of author's statement (*iii*) recognizing differences in purpose of different papers, magazines, (*iii*) recognize agreement and disagreement between two sources, decide which is more acceptable, examine reasons for contradiction, examine for consistency, freedom from bias, recognize propaganda (*ii*)(31)

2. Assessing Statements Using Logical Criteria

problem recognition, defining issues, recognizing assumptions, suggesting solutions, identify relevant sources, identify degree of authority, picks out relevant data, distinguishing fact and opinion, uses statistics, charts, graphs, recognizes bias and propaganda, spots ambiguity (*i*) performing in a panel discussion, examining source material, supporting judgments and rationalization (*iii*)(5) oral speaking, challenging assumptions, picking out assumptions on TV news, political speeches (5) distinguishing fact, opinion, judgment, inference and evaluate each, distinguish sound opinion and those based on fallacies, misleading comparisons, distinguish between reasoned and emotional appeals (55) comparing information on a topic to discover agreement or disagreement, making generalizations, (31) identifying value judgments (49)

C. Inferring

1. Events and People

identification of a valid inference, characteristics of, generate means for testing inferences (16) inferring from listening, about setting, place, people, making inferences about people and social events, conducting data collection, on most liked subject, least liked subject, etc. (51)(49) non-experimental case studies (40)

D. Testing

1. Formulating Hypotheses

tasters and non-tasters, effect of temperature on reaction time (46)

2. Defining Operationally

determining direction, mass, operational definition of plants (46) using dependent and independent variables (40)

3. Controlling Variables

variables affecting chemical reaction, effects of practice on memorization, nutrition, forgetting and relearning, reaction time, growth of plants (46)

4. Interpreting Data

magnetic fields analysis of mixtures, chance, contour maps (46) testing inferences (40) gathering, organizing data, isolations, variables, relationships between variables, hypotheses testing (24) experimenting (46) interpreting research graphs and charts (5) controlling and experimenting recognizing and defining problems, relevant information, hypothesis testing, forming conclusions, recognizing assumptions (12) distinguishing verifiable and unverifiable data, determine recency and adequacy of data, detects errors in data, arranges and presents data, recognize when data is inadequate, reformulates (*i*)

VI. VALUE CLARIFICATION AND DECISION-MAKING SKILLS

Level: Preschool to Second Grade

A. Valuing

1. Reporting Feelings

identify things one likes, dislikes, likes about others, dislikes, anticipates future satisfaction (36) relates class things to home things (30) child uses words angry, mad, happy, sad; child describes a feeling response to role being played, uses words afraid, scared (4) identifying facial expressions, their appropriateness (3) choosing an angry response from others, anticipates what he would do in a particular social situation (3)

B. Evaluating

1. Beginning Value Analysis

views situation in another's perspective (29)(37) child describes what his mother would like, not like, classify the helper vs. the helped in situations, identifying action or series in ambiguous pictures (3) verbalize all people's desire to be loved, evaluate the correct behavior toward shy children by selecting appropriate pictures, will identify how he thinks a child in a picture feels and identify two ways by which he knows when his friend is happy, two occasions when he made someone happy, someone sad (3)

C. Deciding

state problem clearly, list obstacles that stand in the way of solving problem, list best assets in your favor that will help you, generate possible solutions (17) describing a group problem shown in a picture and generates solutions (4) describes, economic, political, social problems (6) given a situation, the learner must look at his own feelings, beliefs, attitudes, thoughts and then decide what he values -- decide course of action that fits with his values (60)

VI. VALUE CLARIFICATION AND DECISION-MAKING SKILLS

Level: Third and Fourth Grades

A. Valuing

1. Reporting Feelings

reporting emotional reactions to problems, hypothetical situations (21) matching pictures to emotions, role playing, generate ways to make people friendlier to you (9)

B. Evaluating

C. Deciding

decision-making exercises relative to the making of America, the metropolitan community, agriculture, industry and the Indian subcontinent (6)

VI. VALUE CLARIFICATION AND DECISION-MAKING SKILLS

Level: Fifth Grade and Beyond

A. Valuing

1. Value (attitude) Clarification

creative exercises: how would you like to be a camera, what does no fence feel like, freedom (52) describe how it would feel to be Claude Brown, Helen Keller (52) value clarification techniques ranking, continuum, public interview, whipping (20) number of ways to answer who am I question, senses and sensations, blocks to our sensing, ambiguity and symbols, either-or, self-deception techniques, advertising ploys (32)

2. Achievement Training

recognizing achievement, searching for causes, recognizing resources, setting goals, trying best method, checking, being ready to change (56) plan experiences for satisfaction, ways of reducing stress (56)

B. Evaluating

1. Behavior

examples of how experience influences behavior, make as similar, different, describe similar behavior with similar causes, different behavior, how people react to stress (56) dynamics of group process, roles of members, characteristics of leader (49) process of development, intelligence, language (49) friendly, unfriendly behavior, loyalty (49) identify feelings with respect to people who are different, concepts of discrimination, stereotype (49) heredity and environment, conformity of group to norms (49) relativity of values, questions of values and attitudes (30) values differ, values originate outside ourselves, values influenced by people, by environment (10)

2. Strategies for Value Analysis

data collecting of change in values and interests over growth, individual differences, sex, age (49) tools for studying value change in a group context (49)(55)

C. Deciding

1. Ethical Decision Making

steps of inferring motivation from behavior, effects of decisions on others, evaluating information carefully, recognize self-deception, ordering values, identify source of values and evaluating them, accepting consequences (10)

2. Personal Decision Making

demonstrate importance of, identify five kinds of personal influence in decision making, demonstrate influence that affects children's decision making (49) identify categories of types of decision making, compare two individuals in decision making, two groups, steps of decision-making process (49)

SELECTED HIGHER ORDER COGNITIVE INSTRUCTIONAL MATERIALS

1. ACADEMIC PRESCHOOL, THE (BEREITER-ENGELMANN LANGUAGE TRAINING PROJECT)

   Bereiter, C. and S. Engelmann. Teaching Disadvantaged Children in the Preschool. Englewood Cliffs, N. J.: Prentice-Hall, 1966.

2. ADVENTURES IN DISCOVERY

   Holl, A. Teacher's Guide to Adventures in Discovery. New York: Western Publishing Company, 1970.

3. AMELIORATIVE CURRICULUM, THE

   Karnes, M. B., et al. The Ameliorative Curriculum: Guilford Activities. Champaign-Urbana, Ill.: University of Illinois, 1970.

4. CHILD (Coordinated Helps in Language Development)

   Northam, S. B. (ed.). CHILD (Coordinated Helps in Language Development—Language Lessons for Kindergarten). Portland, Ore.: Northwest Regional Educational Laboratory, 1970.

5. CHILDREN'S THINKING—HEATHCOTE SCHOOL

   Heathcote School. Children's Thinking. Scarsdale, N. Y.: Scarsdale Public Schools, 1963.

6. CONCEPTS AND INQUIRY

   Educational Research Council of America. Concepts and Inquiry. Boston: Allyn and Bacon, 1970.

7. CONCEPTUAL SKILLS PROGRAM

   Ontario Institute for Studies in Education. Conceptual Skills Program. Toronto, Canada: Ontario Institute for Studies in Education, 1967.

8. COPING CURRICULUM, THE

   Macomber, L. P. The Coping Curriculum—Learning to Learn Curriculum. Unpublished materials, Temple University, Philadelphia, n.d.

9. CREATIVE THINKING KITS: A PROGRAM FOR MIDDLE GRADES

   Youngs, R. C. and S. L. Youngs. Creative Thinking Kits: A Program for Middle Grades. Normal, Ill.: Youngs and Youngs, 1970.

10. DECISION MAKING

    Dodder, C. and B. Dodder. Decision Making. Boston: Beacon Press, 1968.

11. DEVELOPING COGNITIVE SKILLS IN YOUNG LEARNERS

    Classroom Materials Company. Developing Cognitive Skills in Young Learners. Great Neck, N. Y.: Classroom Materials Company, 1967.

12. DIRECT TEACHING OF CRITICAL THINKING IN GRADES FOUR THROUGH SIX

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